PROCESS DESCRIPTION

Drawing 2E–8500 presents the process flow diagram of the circulating fluidized bed boiler. The drawing shows the major process flow streams and indicates the mass flow, temperature and pressure of each of the streams. The flow rates shown on the drawing correspond to boiler design at maximum continuous rating (MCR) conditions and when firing the performance fuel.

FUEL FEEDING SYSTEM

P&ID 2E–8505

Wood waste fuel, conveyed to the top of the bin , is stored in a surge bin with a capacity of 3500 cu ft from which it is withdrawn as required by the combustion process. The fuel feeding system consists of two parallel trains which are normally operated at 50% duty each. The ratio can be adjusted as required and the boiler can be operated at MCR conditions using one feeding system only.

The wood waste is withdrawn from the bottom of the surge bin by two sets of six screws each, which form the live bottom of the bin. The speed of the screws and hence the fuel fed by each set is controlled by the boiler management system according to the preselected ratio between the two parallel feed trains. The fuel from each set of six screws is discharged into a screw conveyor for transfer to the feed chute.

The material discharged from the screw conveyor falls through the feed chute into a rotary valve which isolates the feed system from the combustor. The specially designed rotary valve, which is self–cleaning with an intermittent air purge, discharges the wood waste through a short chute into the recycle ash which is being returned to the combustor. Fluidizing air from the fluidizing air blowers helps move the ash and fuel into the combustor. Directly below each rotary valve, the inlet chute is provided with an automatic fuel isolation valve to protect the feeding systems against excessive temperature during trip and shutdown conditions.

LIMESTONE FEEDING

Crushed and sized limestone is pneumatically transported (by others) and delivered to the limestone storage silo (one (1) common silo for two CFB units). The silo is provided with a dust filter and exhaust fan to facilitate filling.

Limestone is withdrawn from the silo and delivered to the rotary valve. The rotary valve discharges the limestone to the tee joint of a pneumatic conveying system which feeds the seal pot return duct, by means of a single line. Transport air is provided by the positive displacement limestone blowers. Isolation valves are provided on the inlet line to protect the system from hot gases during trips and shut downs.

Limestone rotary valves are controlled proportional to the coal feed rate and the limestone rate is adjusted by the SO2 controller depending upon SO2 emission level in the stack flue gases.

INERT FEEDING SYSTEM

P&ID 2E–8506

Because the quantity of ash from the wood waste is small as well as being generally light and fluffy, inert material (sand) must be added to the combustor to maintain the bed. The sand silo is pneumatically filled by the delivery trucks through a fill line discharging into the top of the silo. The conveying air is discharged through a Dalamatic filter which is periodically pulsed with air to remove the sand collected on the filter elements. The indication of a full silo is provided by a "silo full" signal light mounted on the truck unloading panel.

30889-2E-8510

REVISIONS			
01	D	3/4"	REV. PER CUSTOMER COMMENTS (VCR 02-21-90)
02	D	3/4"	REVISED PER ENGR. REL. #1, SUPP. #11, 15JC 4-22-90.
03	D	3/4"	REV. PER CUSTOMER COMMENTS ENGR. REL. #1, SUPP. #18. (JAD 5-23-90)
04	KK	10-10-90	REV. PER C.E.R. #1, SUPPL. #31, DATED 8-2-90. (REF 8-7-90)

LIMESTONE GATE VALVE
M-281 A (UNIT 1)
M-281 B (UNIT 2)

LIMESTONE VENT FILTER
X-280

LIMESTONE ROTARY VALVE
M-291 A (UNIT 1)
M-291 B (UNIT 2)

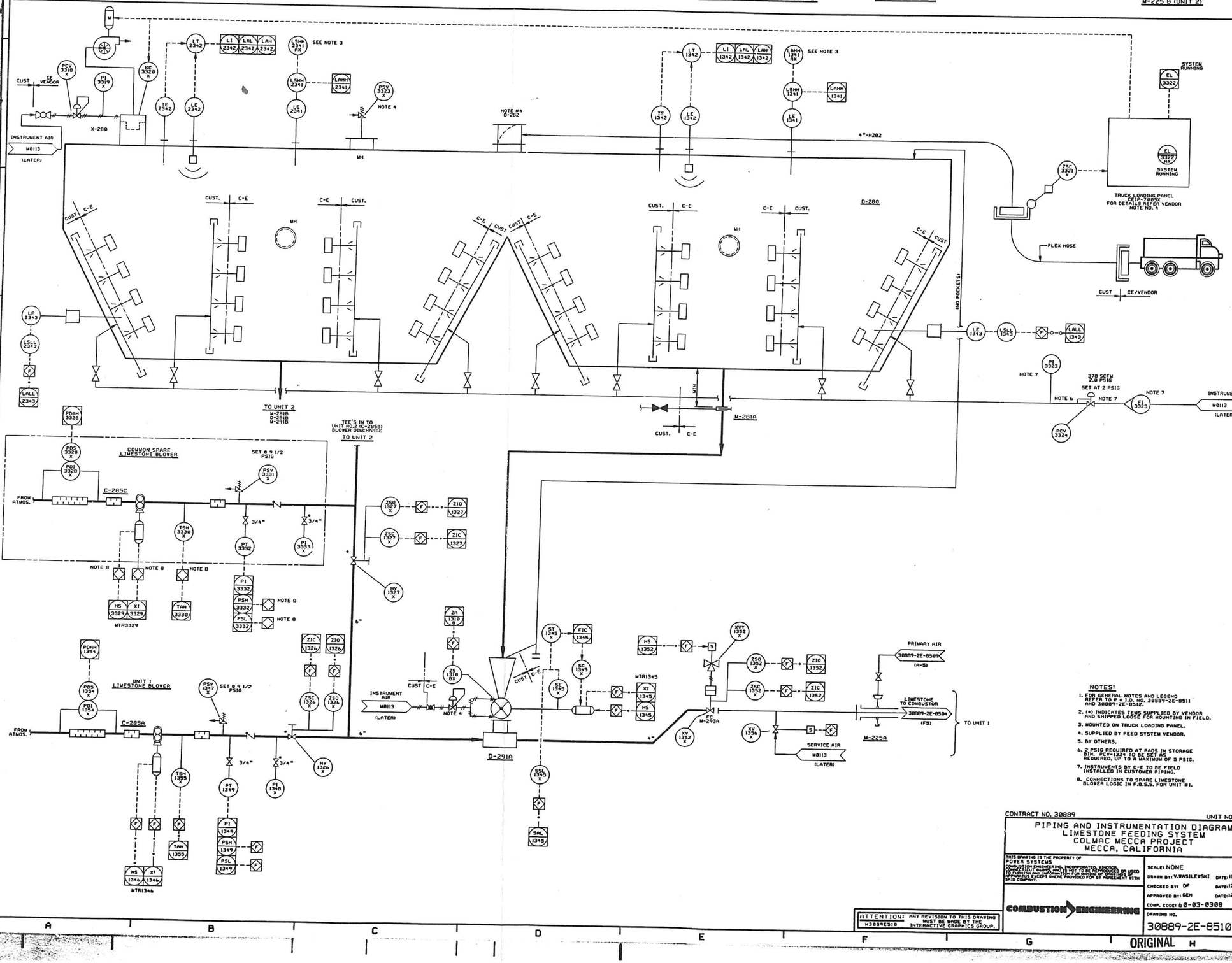
LIMESTONE STORAGE BIN
D-280
LEFT HALF - (UNIT 2)
RIGHT HALF - (UNIT 1)

TARGET BOX
D-282

LIMESTONE BLOWER
C-285 A (UNIT 1)
C-285 B (UNIT 2)
C-285 C (STANDBY FOR UNITS 1 & 2)

SHUT-OFF VALVES
M-293 A (UNIT 1)
M-293 B (UNIT 2)

INJECTION LANCE
M-225 A (UNIT 1)
M-225 B (UNIT 2)



NOTES:

1. FOR GENERAL NOTES AND LEGEND REFER TO P & I.D. NO. 30889-2E-8511 AND 30889-2E-8512.
2. (*) INDICATES ITEMS SUPPLIED BY VENDOR AND SHIPPED LOOSE FOR MOUNTING IN FIELD.
3. MOUNTED ON TRUCK LOADING PANEL.
4. SUPPLIED BY FEED SYSTEM VENDOR.
5. BY OTHERS.
6. 2 PSIG REQUIRED AT PADS IN STORAGE BIN. PCV-1324 TO BE SET AS REQUIRED, UP TO A MAXIMUM OF 5 PSIG.
7. INSTRUMENTS BY C-E TO BE FIELD INSTALLED IN CUSTOMER PIPING.
8. CONNECTIONS TO SPARE LIMESTONE BLOWER LOGIC IN F.B.S.S. FOR UNIT #1.

CONTRACT NO. 30889 — UNIT NO'S. 1 & 2

PIPING AND INSTRUMENTATION DIAGRAM
LIMESTONE FEEDING SYSTEM
COLMAC MECCA PROJECT
MECCA, CALIFORNIA

SCALE: NONE
DRAWN BY: V.VASILEWSKI DATE: 11-9-89
CHECKED BY: DF DATE: 12-12-89
APPROVED BY: GEN DATE: 12-13-89
COMP. CODE: 60-03-0308

COMBUSTION ENGINEERING

DRAWING NO. 30889-2E-8510 REV. 04

ATTENTION: ANY REVISION TO THIS DRAWING MUST BE MADE BY THE INTERACTIVE GRAPHICS GROUP.
N30894510

ORIGINAL

SO. 42

DESCRIPTION OF PLANT EQUIPMENT

CFB COMBUSTION SYSTEM

Fuel Feed System

Wood waste is delivered by others into the top of the wood surge bin (D–210) and is fed from the bottom of the bin into the combustor via two parallel feed trains. Under normal conditions, both feed trains are in operation. However, each train is sized to feed up to 100% of the design fuel supply , in case it is necessary to perform maintenance work on one of the trains.

Wood waste is removed from the bottom of the surge bin at a variable rate as required by the operation of the boiler by two sets of six screws each. Each set of six screws discharges into a screw conveyor which in turn empties into a chute feeding a rotary valve. The wood waste discharged from each rotary valve passes through an isolation knife gate valve by gravity and joins the recycled material from the recycle cyclone that is being returned to the combustor.

COMPONENT DESCRIPTION

Wood Surge Bin (D–210)

The wood surge bin is a mild steel reverse sloped bin with a storage capacity of 3500 cu. ft. The top of the bin is 8 ft wide by 12 ft long and the bottom is 12 ft wide by 16 ft long with 22 ft high sloping sides and with an additional 3 ft vertical screw feeder housing. The bin is equipped with A.R. wear plates on the bottom and inspection/cleanout doors at the bottom level. The bin has two (2) low–low level switches.

Screw Feeders (M–201ABC) (M–201DEF) (M–201GHI) (M–201JKL)

The screw feeders which form a live bottom to the surge bin are arranged in two sets of six screws each. Each set of six screws is powered through two (2) variable speed drives and discharges by way of a short chute into a screw conveyor – one chute and conveyor for each set of six screw feeders. These variable speed screw feeders provide the primary control of the fuel feed rate. Although normally both sets of screw feeders will be operating, each set alone has sufficient capacity to provide the design fuel for operation at the MCR rate. Each set of screws is provided with two (2) zero speed switches.

Screw Conveyors (M–202A/B)

The screw conveyors, driven by single speed motors, transport the wood waste from the screw feeder discharge to the feed chute for the rotary valves. Each screw is 24 inches in diameter in a "U" shaped trough and has sufficient capacity for the full fuel rate delivered from six (6) screw feeders. Each screw conveyor has a shaft mounted zero speed switch.

Rotary Valves (M–205A/B)

Two rotary valves, one for each train, are provided. Each valve, operating at 44 rpm and driven by a 10 HP motor, is designed to provide the full fuel flow. The valves receive fuel from the screw conveyors and discharge it to the feed chutes to the combustor. A zero speed switch is provided on each rotary valve. An interlock switch is also provided to prevent operation of the valve when the cover is opened.

Isolation Valves (M–204A/B)

A piston operated knife gate isolation valve is provided beneath each rotary valve to protect the feed system from excessive temperature in the event of shutdown.

Inert Feed System

Inerts (sand) are discharged by gravity from the sand storage silo into the sand pump through the special dome valve. The sand pump is pressurized with air and the sand is conveyed by dense phase into the ash return duct where it enters the combustor with the recycle material. The addition of sand is automatically controlled by the combustor pressure differential.

COMPONENT DESCRIPTIONS

Sand Storage Silo (D–220)

The sand storage silo is a cylindrical carbon steel vessel 10 ft in diameter and approximately 21'–6" high with a cone roof and an 8'–4" high 60° cone bottom. The silo is equipped with a vent filter, fill pipe, access ladder and high, low and low–low level probes.

Sandpump (S–222)

The sandpump is a two cubic foot cylindrical carbon steel vessel with a cone bottom supplied with the necessary piping and instrumentation to charge sand into the combustor on an intermittent basis.

Limestone Feed System

Limestone feed is delivered by others and pneumatically pumped into the fill system of the limestone storage silo. At the silo discharge,it is fed through a rotary valve to a tee member and downstream to the combustor.

COMPONENT DESCRIPTION

Limestone Storage Silo (D–280)

One limestone storage silo is provided and is common to two (2) CFB units.

The limestone storage silo is a rectangular cross section 14 feet wide by 18 feet long by 22 feet high of mild steel with a storage capacity of 5833 cu. ft. The lower section consists of dual pant legs sloped to twin 18 inch square discharge openings.

The silo includes two (2) manhole/cleanout doors, various level switches, dust collector and pneumatic fill station.

Limestone Rotary Valve (M–291 A/B)

The limestone rotary valve receives material from the limestone storage silo.

The valve is of cast high brinell internals. The valve is provided with a vented inlet hopper and is driven by a 1 HP gear motor.

Limestone Air Blowers (C–285 A/B/C)

The air blowers are steel mounted units containing all valves gauges, switches, silencers and filters. The blowers are driven by 40 HP TEFC drives with all enclosed in an acoustical structure. One blower is used as a common spare for the two (2) units.

Combustion Chamber

The CFB combustion chamber (F–301) is a rectangular waterwall design with the lower portion of the waterwall tapered and refractory lined.

COMPONENT DESCRIPTION

Lower Refractory–Lined Combustor Section

Fuel combustion proceeds in two zones: a primary reducing zone in the lower section, and final combustion at 48% excess air in the middle and upper sections. Primary fluidizing air, representing roughly 50% of the total air to the combustor, is supplied under pressure from the primary air fan through a windbox and grate assembly at the bottom of the combustor. The grate design is essential for achieving the optimum fluid dynamic conditions in the circulating bed.

The fluidizing grate essentially consists of:

1. A metal sheet bottom plate for the combustor, including supports and stiffeners
2. Horizontal bore–hole type fluidization nozzles, made from heat resistant material spaced on approximately 1 foot intervals
3. An abrasion resistant refractory lined grate
4. Windbox, connected to the combustor and sealed. This serves as a plenum for air distribution

Multiple ports are provided in the lower section for fuel feed and solids return from the cyclone, burner lances, secondary air inlet ports, heat–up burners and manholes. Observation ports and instrument nozzles are located as required in the combustor.

The refractory lining in the lower combustor section serves two purposes. First, the heat loss is minimized, thus allowing for faster hot restarts. Second, the possible corrosion effects of the reducing environment are eliminated

The lower section is about 20 feet high and tapers near the bottom towards the grate. Refractory materials are designed for erosion protection. The grate area is approximately 157 ft≅.

Upper Waterwall Combustor Section

The upper section is rectangular in design and is made up of exposed evaporative waterwalls. This waterwall section provides all of the evaporative duty of the boiler.

At the entrance of the upper combustor section, secondary air, comprising roughly 50% of the total combustion air, is introduced through ports located in the sidewalls. This brings the stoichiometric stream leaving the lower combustor to a final composition of 48% excess air, thus insuring complete combustion.

The solids density gradient decreases as the stream moves up through the upper combustor. At the top of the upper combustor section, the stream exits through an opening in the side wall and proceeds to the cyclone.

Combustor Operating Pressure

Bottom Level	44 in–wg
Gas Outlet	4 in–wg

Component Description

Refer to other sections of this volume for details.

Solids Recycle

Flue gas and the entrained solids leaving the combustor enter the cyclone (S– 360). In the cyclone about 99.9% of the solids are captured. The solids separated by the cyclone flow downward into a stand pipe, ending in a refractory lined–air fluidized seal pot. The seal pot arrangement returns the solids separated by the cyclone to the lower combustor section.

COMPONENT DESCRIPTION

Recycle Cyclone (S–360)

One (1) recycle cyclone is provided for this system. The cyclone is fabricated from carbon steel and is refractory lined. The cyclone has an inside diameter of 21' and an overall height of approximately 51'.

Stand Pipe (Seal Pot Inlet Duct)

One (1) stand pipe is provided. The pipe is 3' –6" in inside diameter, refractory lined and is provided with an expansion joint at the cyclone outlet.

Seal Pot (V–360)

The seal pot is a refractory lined, carbon steel vessel provided with fluidizing nozzle grid and air header. The inside dimensions are approximately 11' long by 3'–6" wide by 4' high.

Ash Cooling

Ash is discharged intermittently from the combustor at 1625°F through the ash discharge valve to the screw ash cooler. As the ash flows through the screw ash cooler, it is cooled to 450°F by cooling water and discharged to the ash handling system .

COMPONENT DESCRIPTION

Ash Discharge Valve (M–301)

One ash discharge valve of knife gate design is supplied between the combustor and ash cooler. The valve is equipped with special water–cooled cooling flanges on both sides of the gate.

Ash Drain Chute (D–390)

One drain chute (10" I.D.) fabricated from temperature resistant material with an insulated casing is provided.

Screw Ash Cooler (E–320)

One screw ash cooler, manufactured by Joy–Denver, is supplied. The cooler is provided with a hollow flight screw through which cooling water is passed and is designed to cool 5000 lb per hour of ash to 450°F. Cooling water is also passed through a jacket around the trough and plate at the hot end of the unit. The screw ash cooler is driven by a variable speed motor which is controlled by the pressure differential across the combustor gas outlet (to cyclone) and grate.

Combustion and Fluidizing Air Supply

The combustion air is supplied to the CFB combustor in two main streams: the primary air and the secondary air. In addition to these main streams, fluidizing air is used for recycling solids via the siphon seal at the seal pot. The flow of air into the combustor is integrated and recorded and is automatically proportioned to the wood feed rate in order to maintain the required excess air ratio for combustion.

COMPONENT DESCRIPTION

Primary Air Fan (C–310)

The primary air fan is a single stage carbon steel unit provided with inlet vane control and manufactured by Howden; size 717008 L1 and arrangement #3 SWSI. It has a test block capacity of 44,040 SCFM at 92" W.C. The fan is driven by a 900 HP motor with a WP II enclosure and supplied with an inlet filter and discharge check damper.

Secondary Air Fan (C–320)

The secondary air fan is a single stage carbon steel unit provided with inlet vane control and manufactured by Howden; size 614010 L2N and arrangement #3 SWSI. It has a test block capacity of 43,680 SCFM at 65" W.C.

The fan is driven by a 700 HP motor with a WP II enclosure and supplied with an inlet filter and discharge check damper.

Ash Fluidizing Air Blowers (C–330A/B)

Two positive displacement air blowers manufactured by Roots, Model No. 624 RCS are supplied. One unit is an installed spare. Each blower has a capacity of 2412 SCFM at 23.14 psia and is belt driven by a 150 HP motor. An inlet and outlet silencer are provided with each blower.

Combustion Air Ductwork

1. Inlet duct to the primary air fan.
2. Inlet duct to the secondary air fan.
3. Pressure duct from the outlet of the primary air fan (C–310) to the burners (for start–up) and to the inlet of the combustor windbox (F–301).
4. Pressure duct from the outlet of the secondary air fan (C–320) to the lower and upper inlet ports for secondary air approximately 6 and 18 ft above the combustor grid respectively.
5. Pressure duct from the outlet of the fluidizing air blowers (C– 330A/B) to the seal pot.

All primary, secondary and fluidizing air ducts are fabricated from carbon steel, properly stiffened and reinforced, complete with the necessary expansion joints and dampers.

BURNER SYSTEMS

Start–up Burner System (F–304)

The start–up burner system consists of a manually retractable burner for firing natural gas located in the FRONT wall of the combustor at an elevation of approximately 24 ft. The burner is equipped with an electrically ignited continuous pilot, sight glass and two flame scanners. the burner has a maximum firing capacity of 86 million Btu/hr and a 5 to 1 turndown ratio.

Heat–up Lance Burner, System (F–305A/B)

The heat–up lance burner system consists of two manually retractable lance burners located in the FRONT wall of the combustor at an elevation of approximately 17 ft.

Each lance has a firing capacity of 40 million Btu/hr, and they will be operated simultaneously by group control. Each lance is capable of operating at a minimum firing rate of 10 million Btu/hr.

The lances are provided for load/process stabilization should the wood waste feeding system experience an upset. The lances can be manually moved into the firing position provided the middle combustor temperature is above 1400°F. The fuel valves can then be opened with a start button to put the lances into operation. The heat of the bed will provide the necessary ignition energy.

Burner Valve Rack

The control valves, flow meters and block and bleed valves for all the burners, with the exception of the final block valves for the start–up burner and its pilot, are all installed on a burner rack located near the burners. Manual and automatic block valves are also located in the inlet fuel line at the rack. Natural gas is supplied by others to the burner valve rack at a pressure of 40 psig and a temperature of 70–120°F. A gas meter provided by P G & E is located at the main entrance to the plant.

COMPONENT DESCRIPTION	
Start–Up Burner (F–304)	
Heat Release	86 x 10^6Btu/hr
Firing Rate	Natural gas: 1575 scfm
Combustion Air	17,000 scfm at 62" W.G. and 381°F
Sweep Air	i) 510 scfm for plenum cooling when notfiring ii) 10 scfm each for burner and ignitorguide tube cooling/purging
Plant Air	66.5 scfm at 100 psig (for pilot combustion air)
Instrument Air	10 scfm for purging/cooling of flame scanner and sight glass
Burner Assembly	Burner with mounting flange, pilot, sight glass, limit switches, and isolation gate valves
Flame Safeguard	Self–checking UV scanner and amplifier with flame intensity indicator
Pilot Assembly	Flange mounted with air/natural gas mixing tee and high energy spark ignitor

Heat–Up Lances (F–305A/B) 2 assemblies are provided	
Heat Released	40 x 10^6Btu/hr each
Firing Rate	Natural gas: 750 scfm each
Sweep Air	40 scfm each for purging/cooling of burner
Burner Assembly	Burner with mounting flange, limit switch and isolation gate valve
Burner Valve Rack	
Shutoff Valves	Maxom valves for gas header and block and vent valves for gas lines to all burners. Asco valves for block and vent valves for all pilot gas lines
Flow Control Valves	Fisher control valves with pneumatic operators in gas line to each system
Natural Gas Flow Meters	Hoffer HO turbine flowmeters in the gas line to each system

THERMAL DENOX SYSTEM

Refer to manufacturers'instructions elsewhere in these manuals.